MISSOURI DEPARTMENT OF NATURAL RESOURCES (/)

Drought Response, Recovery and Resilience: A Guide for Public Water Systems - PUB2745

Water Protection Program

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Division of Environmental Quality

Director: Kyra Moore

Seasonal droughts are common in Missouri, but prolonged, severe drought conditions present a variety of operational, technical, financial and public relations challenges for public water systems. This fact sheet describes common issues that arise from periods of extended drought and provides guidance on how public water systems can prepare for, respond to, and recover from severe drought. This document also provides a summary of strategies and practices that public water systems may consider to develop additional resilience to future episodes of drought.

Overview

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- Drought Impacts on Water System Infrastructure.
- Socio-Economic Impacts of Drought on Public Water Systems.
- Drought Planning, Preparedness, and Resilience.
- Drought Funding Resources

Drought Impacts on Public Drinking Water Sources

Public water systems in Missouri use a variety of raw water sources that exhibit a wide range in water quality and quantity. Surface water sources include lakes, reservoirs and streams of varying size. Groundwater sources include large, regionally extensive aquifers such as the Ozark aquifer, high-volume alluvial aquifers such as the Missouri River alluvium and small, localized aquifers along smaller tributaries or ancient, buried river channels. Although the degree of impact is variable, all public water sources in Missouri are potentially vulnerable to extended or prolonged drought.

Most surface water systems in Missouri use reservoirs or a series of reservoirs for raw water storage. A fundamental purpose of a drinking water reservoir is to maintain sufficient water supply capacity to operate without interruption through seasonal wet and dry periods (while still

meeting daily and peak periods of demand). Although many systems can divert water from streams, small- and medium-sized tributaries often have little, if any, flow during episodes of severe drought. Lakes with small drainage basins, also, may have no appreciable runoff or recharge. Larger reservoirs may be able to satisfy a water system's demand for one or more years without significant recharge, but small and medium reservoirs are acutely vulnerable to extended drought, particularly if there are no supplemental water sources available.

Although water quantity is a primary concern throughout prolonged drought, raw water quality problems are also typical. Several factors combine to degrade water quality within drought-impacted reservoirs and, generally, as water levels decline, so too does the water quality. Due to eutrophication, most Missouri lakes and reservoirs stratify into distinct layers, with lower quality water in the deeper portions of the reservoir and the higher quality water in the uppermost layer. As the higher quality water is consumed, the remaining water exhibits increased concentrations of total dissolved solids, inorganic compounds, organic materials, nutrients, and sediments. Any surface runoff available is also likely to contain elevated levels of these constituents, which, along with increased water temperature in the reservoir, can promote algal blooms and other problems on an already strained system.

Public water systems that use groundwater wells may also experience complications due to prolonged drought. Shallow, localized aquifers are most prone to drought impacts because they generally rely on surface water infiltration or flow in surface streams to recharge. Wells that draw from these aquifers can exhibit dramatic drops in static water level due to lack of recharge or over-pumping. As a shallow, localized aquifer depletes, levels of total dissolved solids, alkalinity, salinity, organic materials, and inorganic compounds can increase rapidly.

Large, high-volume aquifers such as the Ozark aquifer and alluvial aquifers along the Missouri and Mississippi rivers are less prone to immediate impacts from drought. Longer-term drought conditions, though, can influence water quality and quantity even within large aquifers. A steady decline in static water level on a regional or local scale can mobilize surface and shallow subsurface contamination by drawing it deeper into the subsurface. Subtle variations in raw water chemistry, too, may challenge a system designed to treat specific, predictable water quality conditions. If these subtle variations are not recognized or if treatment processes are not adjusted appropriately, finished water may exhibit taste and odor variations, increased or decreased corrosivity or other undesired characteristics.

Drought Impacts on Water System Infrastructure

Although water level decline may be the first sign of drought-related impact for a water system, stress on system infrastructure is a serious threat to the system. From the source to the tap, nearly every stage of water treatment and distribution is vulnerable to drought. Several common infrastructure problems related to drought include:

- Clogged raw water intakes or well screens.

- Overworked or failing raw surface water pumps.
- Wells failing to produce water, due to either stressed or failed well pumps or static water levels dropping below the well pump.
- Electrical equipment failures related to soil moisture loss and loss of electrical grounding or overheating.
- Degraded, failed, or ineffective treatment processes due to altered raw water quality.
- Pressure loss from leaks, main breaks or excessive consumer demand.
- Loss of finished water storage due to main breaks or failed valves.

Extended drought conditions strain the weakest points of a distribution system, which can lead to cascading failures throughout the system. Rapid changes in pressure can result in a variety of system failures or water quality issues. A repaired water main, for example, can result in a rapid pressure increase further along in the distribution system, potentially causing additional line breaks or stirring up sediments or deposits within mains. Most water systems in Missouri strike a delicate balance between infrastructure maintenance, repair and available resources. During an extended drought, delayed maintenance can quickly turn into an emergency water shortage.

Socio-Economic Impacts of Drought on Public Water Systems

Extended drought impacts nearly every facet of a community. Localized water shortages due to main breaks can occur frequently and unpredictably, leaving consumers without water and potentially affecting local businesses, commerce, tourism, recreation and more. Many systems have emergency reserve funds as part of their technical, managerial and financial capacity development programs, but nearly simultaneous system failures due to drought can quickly deplete or overwhelm these resources. Pumps, valves or mains may fail far more quickly than anticipated. Systems may have to hire additional staff to handle repairs or customer complaints. Systems may have to develop emergency contracts for additional labor or to acquire supplemental water sources. Moreover, unlike most other natural disasters, government assistance programs for drought may or may not be available. Smaller communities, in particular, are vulnerable to large, unpredicted expenses.

Communicating with the public during a drought is essential. Extended drought can impact water systems in close proximity to each other in very different ways – news reports or coverage of water shortages from other communities may generate unnecessary concern or decrease public confidence in the system. Likewise, if a system is experiencing significant complications due to drought, the consumers need to know the status and severity of the issues. Issuing regular, consistent, honest and direct messages to the public can minimize customer concerns and help the community adjust behaviors and water use as appropriate. Additionally, an informed community is far more likely to support water conservation measures or rate adjustments in response to an extended drought.

Drought Planning, Preparedness, and Resilience

Building resilience to drought includes planning, preparation, communication, coordination and operational expertise. These same elements are part of a water system's general emergency operations plan, but unlike other natural disasters many impacts from extended drought are predictable. Case studies of impacts from and responses to drought by public water systems are widely available and a valuable resource for water system and community planners. A public water system cannot prevent drought or predict its length or severity, but it can put itself in the best position possible to operate through one while sustaining the community it serves.

The first step is to develop local and regional drought response planning teams. Severe drought rarely affects just one community. Emergency interconnections with neighboring water systems are valuable and highly recommended, but if one system is experiencing impacts from drought, it is likely nearby systems are as well. A local drought response planning team should include system operators, board or council members (or other decision makers), local engineering experts, legal and regulatory experts and financial planners. The goal of this team is to develop a local drought response plan, which includes identifying potential impacts from drought, weaknesses in the system, and goals to minimize impacts. Given the regional nature of droughts, systems are encouraged to develop or participate with a regional drought response team. This team might include representatives of other public water utilities in the region, regional planning entities, county-based local emergency planning commissions, or even state-level representatives. Most of these entities already have emergency communication networks in place that may prove invaluable if a particular system experiences a catastrophic issue. Every public water utility should have an active emergency response plan – including a specific section on drought response that will further refine the system's capacity to endure prolonged drought.

A local drought response plan may contain a variety of information to address many contingencies, but critical elements or action goals of an effective plan include:

- Identifying infrastructure weaknesses.
- Identifying critical or sensitive water customers.
- Estimates of the length of time the system can operate without any additional recharge of the source (i.e., the worst-case scenario) or supplemental water sources.
- Identifying feasibility and cost-benefit analyses for short-, intermediate-, and long-term options for supplemental water sources. These may include permanent or emergency interconnections with other systems, development of new raw water sources, or contingency plans for emergency water hauling or bottled water providers.
- Drought response stages that trigger specific, tiered conservation measures or emergency-tiered rate structures. These might include voluntary measures or use-reduction goals that can escalate to water-use restrictions or enforceable actions.
- A communications or public information plan – this plan should include specific, targeted messages and identify the media through which they are to be delivered.

- A thorough analysis of the utility's financial capabilities and a list of possible financing options to respond to an emergency. This may also include options for establishing a dedicated local funding mechanism for emergency response.
- A systematic checklist or process to assess impacts, responses, or other relevant observations from current or past episodes of drought.
- A list of potential assistance providers.
- A regular schedule for review and exercise of the plan.

Missouri developed the **Missouri Drought Plan (/document-search/2002-missouri-drought-plan)** in 1995 (revised in 2002) to provide a formal outline for state-level responses to drought. Local and regional drought response teams are encouraged to review the plan and to develop their local or regional plans to synchronize with the statewide plan. The plan is a tremendous resource and provides a scalable framework within which federal, state, regional, and local governments (and nongovernmental organizations) can coordinate drought response activities and share information.

From an operational perspective, developing resilience to drought is all about preparation, maintenance, and proper fiscal management. Ensure the system is optimized and operating as efficiently as possible through:

- Regular maintenance of distribution mains and valves.
- Establishment of a regular schedule for system upgrades.
- Use of meters to identify water loss. All public water utilities are strongly encouraged to develop a water loss identification and repair schedule – although distribution repairs are costly, every gallon of water lost is revenue lost.
- Analysis of routine supply and demand characteristics and development of techniques to moderate supply and demand under various possible water conservation scenarios.
- Regular review of financial capacity to ensure the utility has enough capital to respond to emergency repairs. This may also include a list of emergency technical assistance providers or emergency contract operators.
- Engineered design modifications or improvements to promote redundancy and resilience within the system.
- Development of a program to assist or provide guidance to consumers that may have leaks within their private service lines. This can be especially important for systems that do not have service line meters already in place.

Drought Funding Resources

The Missouri Department of Natural Resources' Water Protection Financial Assistance Center provides funding opportunities to communities for water infrastructure improvements, including projects that improve a system's drought resilience.

- The State Revolving Fund is a federally capitalized, low-interest loan program that may be used to finance installation of or improvements to water treatment and distribution that improve drinking water quality to comply with Safe Drinking Water Act regulations
- The Small Borrower Loan Program is available only to communities or public sewer districts of less than 1,000 population or service area. Qualifying communities or public sewer districts may be considered for a direct loan for wastewater system improvements for up to $100,000 with a maximum 20-year repayment term.
- The department may make emergency funds available through an Emergency Drinking Water Financial Assistance Program for publicly-owned drinking water systems that serve fewer than 10,000 and are within a drought area designated by Executive Order. An eligible project must be necessary to ensure an adequate supply of safe drinking water to the service area of a publicly owned drinking water system experiencing a serious and immediate threat from drought.

Nothing in this document may be used to implement any enforcement action or levy any penalty unless promulgated by rule under chapter 536 or authorized by statute.

For more information

Water Protection Program

1101 Riverside Drive
PO Box 176
Jefferson City, MO 65102-0176
United States

Main
573-751-1300 (tel:573-751-1300)
Toll-free
800-361-4827 (tel:800-361-4827)
Fax
573-526-1146 (tel:573-526-1146)
cleanwater@dnr.mo.gov (mailto:cleanwater@dnr.mo.gov)